SERS-enhanced piezoplasmonic graphene composite for biological and structural strain mapping.

Journal: Nanoscale

Publication Year: 2017

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PubMed link: 28055038

Funding Grants: Development of 3D Bioprinting Techniques using Human Embryonic Stem Cells Derived Cardiomyocytes for Cardiac Tissue Engineering

Public Summary:
This work demonstrates the use of graphene decorated with metallic nanoislands for sensing of tensile deformations. The nanocomposite films contain gaps between the nanoislands, which behave as hot spots for surface-enhanced Raman scattering (SERS). Mechanical strain increases the sizes of the gaps; this increase attenuates the electric field, and thus attenuates the SERS signal. This compounded, SERS-enhanced effect can be quantified using a plasmonic gauge factor, and is among the most sensitive mechanical sensors of any type. Since the graphene-nano-films are both conductive and optically active, they permit simultaneous electrical stimulation of myoblast cells and optical detection of the strains produced by the cellular contractions. This work leads to precision measurement of strain in cells.

Scientific Abstract:
Thin-film optical strain sensors have the ability to map small deformations with spatial and temporal resolution and do not require electrical interrogation. This paper describes the use of graphene decorated with metallic nanoislands for sensing of tensile deformations of less than 0.04% with a resolution of less than 0.002%. The nanoisland-graphene composite films contain gaps between the nanoislands, which when functionalized with benzenethiolate behave as hot spots for surface-enhanced Raman scattering (SERS). Mechanical strain increases the sizes of the gaps; this increase attenuates the electric field, and thus attenuates the SERS signal. This compounded, SERS-enhanced "piezoplasmonic" effect can be quantified using a plasmonic gauge factor, and is among the most sensitive mechanical sensors of any type. Since the graphene-nanoisland films are both conductive and optically active, they permit simultaneous electrical stimulation of myoblast cells and optical detection of the strains produced by the cellular contractions.